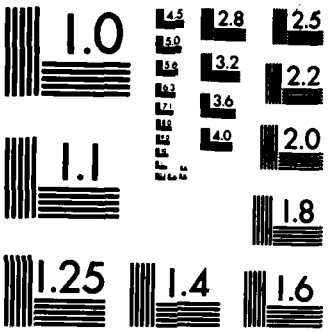
AD-A128 291 RELIABILITY OF COMPUTER SYSTEMS ODRA 1305 AND R-32(U) 1/1
FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OH
W DREWNIAK 25 MAR 83 FTD-ID(RS)T-1796-82

UNCLASSIFIED F/G 9/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FTD-ID(RS)T-1796-82

FOREIGN TECHNOLOGY DIVISION

AD A128291

RELIABILITY OF COMPUTER SYSTEMS
ODRA 1305 AND R-32

by

Wit Drewniak

DTIC FILE COPY

DTIC
ELECTE
MAY 19 1983
S D
D

Approved for public release;
distribution unlimited.

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A	

DTIC COPY FURNISHED TO

EDITED TRANSLATION

FTD-ID(RS)T-1796-82 25 March 1983

MICROFICHE NR: FTD-83-C-000436

RELIABILITY OF COMPUTER SYSTEMS ODRA 1305 AND R-32

By: Wit Drewniak

English pages: 12

Source: Informatyka, Vol. 14, Nr. 7, 1979, pp. 5-8

Country of origin: Poland
Translated by: SCITRAN
F33657-81-D-0263
Requester: RCA
Approved for public release; distribution unlimited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

GRAPHICS DISCLAIMER

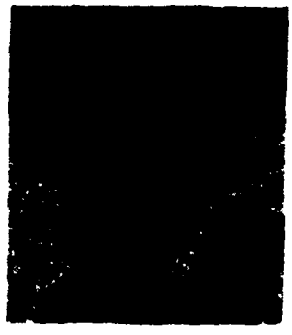
All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

WIT DREWNIAK
Mechanization and Automation Division
Statistical Works GUS
Warsaw

RELIABILITY OF COMPUTER SYSTEMS

ODRA 1305 and R-32

As a result of the rapid growth of the country's computer production, ODRAs and RIADs are being encountered with increasing frequency in the most diverse computer centers — among others in centers which had previously utilized foreign equipment. Following their installation, the Polish computers are beginning to compare with foreign machines. The operational and technical service workers obtain relatively soon a picture of the reliability of the new computer, whereas the management of the computing center does not take cognizance for quite some time of the existence of different categories of computer reliability. /5



Since completing his studies at the Electronics Department of the Polytechnic School of Warsaw (1961), Master Engineer Wit Drewniak has been working in the information section of the Main Statistical Office, where he is now serving as principal technical service specialist in the Mechanization and Automation Division of the Statistical Works. During the years 1962-1977, he was a lecturer at information-oriented technical high schools in Warsaw.

An article by B. Gliksman entitled "Results Obtained During Utilization of the JS EMC computers installed in ZETO, Katowice", Informatyka, No. 7-8/78, deals with various reliability classes within the family of the machines of the Monolithic System. From the tables contained in that article, it is possible to compute the values of time T_m between failures in relation to utilization periods extending over many months.[1] These values had the following pattern for the particular computers used at ZETO Katowice:

R-20 (first year of use) -- 16.1 hours
R-20 (second year of use) -- 52.8 hours
R-22 (first year of use) -- 42.8 hours
R-32 (11 months of use) -- 11.1 hours
R-50 (9 months of use) -- 10.5 hours

Thus, in the first year of use at ZETO, Katowice, the average monthly times between failures amounted to only between ten and twenty hours, whereas they lasted several tens of hours in the second year.

It should be emphasized that the cited article has served the technical service staff as a weighty argument during discussions with the users, who would like to attain times between failures of the order of several tens of hours already in the first year of use, regardless of the computers' relability class.

RELIABILITY INDICES OF COMPUTER UTILIZATION AT OE GUS, WARSAW

We know from utilization experience that absolute perfection of technical objects (installations) is unattainable; hence these

---

*The times T_m given below for the ZETO, Katowice, machines and the times T_λ^m for the machines of the Electronics Center GUS in Warsaw were computed in accordance with Formula (1).

objects (especially computer installations in view of their exceptional structural make-up) are subject to malfunctions.

A certain measure of the reliability of an object (installation, system) is the average time between two successive malfunctions of this object in a defined period of use. This time — $T\lambda$[2)] — commonly called the reliability index, is mathematically defined by the average value of the probability function that denotes the time of correct operation between the object's two successive failures. This assumes the form: /6

$$T_{\lambda i} = \frac{1}{m_i} \sum_{j=1}^{m_i} t_{ij} \qquad (1)$$

where: m_i = the number of observed failures of the i-th object in a given period of utilization

t_{ij} = operation time of the i-th object from the end of repair of the object after the preceding (j-1)-th failure until the object's next (j-th) failure.

Since the year 1978, investigations were conducted at the Electronics Center GUS in Warsaw of the operational reliability of the computer systems used there. The results of these investigations are presented in the Tables that are given below.

From the data below it follows that the characteristic reliability index $T_{\lambda j}$ pertaining to a one-year period of use is in the range of 20-30 hours for the ODRA 1305 computers, 7 to 9 hours for the R-32 machine, about 50 hours (with a decreasing trend in the 12th year of use) for the ICL 1905 machines, and about 100 hours for the ICL 1903A machine.

---

*In English literature, the time T_λ is defined by the abbreviation MTBF (Mean Time Between Failures).

ODRA 1305, Serial No. 208, Second Year of Use

① Miesiąc/rok		01/78	02/78	03/78	04/78	05/78	06/78	07/78	08/78	09/78	10/78	11/78	12/78
② Łączny czas pracy [h]	t_p	543	504	568	512	516	550	543	575	575	688	598	486
③ Łączny czas awarii [h]	t_a	16	17	15	25	16	16	9	28	8	13	40	24
④ Liczba przestojów awaryjnych	m_i	37	31	43	43	58	33	16	27	22	20	28	42
⑤ Średni czas między uszkodzeniami [h]	$T_{\lambda i}$	14,2	15,7	12,8	11,2	8,6	16,4	33,3	19,8	17,7	20,3	15,5	11,9

Key: 1) month/year; 2) total operating time (hours); 3) total breakdown time (hours); 4) number of breakdown interruptions; 5) average time between failures (hours).

The value $T_{\lambda j}$ for a yearly period of use amounted to 14.8 hours in 1978 (and 15.1 hours in the first year of use).

ICL 1903A, Serial No. 431, Ninth Year of Use

① Miesiąc/rok		01/78	02/78	03/78	04/78	05/78	06/78	07/78	08/78	09/78	10/78	11/78	12/78
② Łączny czas pracy [h]	t_p	562	525	586	520	515	560	540	577	584	688	528	478
③ Łączny czas awarii [h]	t_a	—	3	2	15	6	5	—	1	—	—	1	5
④ Liczba przestojów awaryjnych	m_i	2	4	5	5	5	5	2	2	—	3	4	4
⑤ Średni czas między uszkodzeniami [h]	$T_{\lambda i}$	276	136,5	116,8	111	101,3	112,3	274,5	182	584	281	188	118,5

Key: 1) month/year; 2) total operating time (hours); 3) total breakdown time (hours); 4) number of breakdown interruptions; 5) average time between failures (hours).

The value $T_{\lambda j}$ for a yearly period of use amounted to 160.2 hours in 1978 (and 55.9 hours in the preceding year).

ICL 1905, Serial No. 201, Twelfth Year of Use

① Miesiąc/rok		01/78	02/78	03/78	04/78	05/78	06/78	07/78	08/78	09/78	10/78	11/78	1[illegible]
② Łączny czas pracy [h]	t_p	552	514	579	510	508	561	541	575	534	553	528	[illegible]
③ Łączny czas awarii [h]	t_a	4	5	44	11	3	15	5	4	3	2	4	
④ Liczba przestojów awaryjnych	m_i	18	12	40	7	6	17	11	10	11	6	9	
⑤ Średni czas między uszkodzeniami [h]	$T_{\lambda i}$	39,4	42,4	13,3	71,2	84,1	32,1	48,7	57,1	48,2	91,8	58,2	

Key: 1) month/year; 2) total operating time (hours); 3) total breakdown time (hours); 4) number of breakdown interruptions; 5) average time between failures (hours).

The value $T_{\lambda j}$ for a yearly period of use amounted to 40.0 hours in 1978 (and 72.5 hours in the preceding year).

ODRA 1305, Serial No. 197, Second Year of Use

① Miesiąc/rok		01/78	02/78	03/78	04/78	05/78	06/78	07/78	08/78	09/78	10/78	11/78	12/78
② Łączny czas pracy [h]	t_p	375	335,5	375,5	363	348	393	380,5	398	444,5	552	537,5	486
③ Łączny czas awarii [h]	t_a	37	57	6,5	10	14	13	14	17	10	10	20	44
④ Liczba przestojów awaryjnych	m_j	24	23	9	8	10	25	13	15	7	15	15	64
⑤ Średni czas między uszkodzeniami [h]	$T_{\lambda j}$	14,9	12,1	41,9	44,1	33,4	15,2	28,8	25,4	62,0	36,1	34,5	6,9

Key: 1) month/year; 2) total operating time (hours); 3) total breakdown time (hours); 4) number of breakdown interruptions; 5) average time between failures (hours).

The value $T_{\lambda j}$ for a yearly period of use amounted to 20.7 hours in 1978 (and 23.3 hours in the first year of use).

ODRA 1305, Serial No. 233, Second Year of Use (only 4 months of operation in the preceding year)

① Miesiąc/rok		01/78	02/78	03/78	04/78	05/78	06/78	07/78	08/78	09/78	10/78	11/78	12/78
② Łączny czas pracy [h]	t_p	375	336	376	363	348	393	381	399,5	454	552	529	484,5
③ Łączny czas awarii [h]	t_a	4	13	5,5	10,5	9	5	4	5,5	2	2	7,5	7
④ Liczba przestojów awaryjnych	m_j	15	13	11	16	12	20	13	12	7	8	8	20
⑤ Średni czas między uszkodzeniami [h]	$T_{\lambda j}$	24,7	17,9	33,6	22,0	28,2	19,4	27,4	33,8	64,5	69,0	104,3	18,4

Key: 1) month/year; 2) total operating time (hours); 3) total breakdown time (hours); 4) number of breakdown interruptions; 5) average time between failures (hours).

The value $T_{\lambda j}$ for a yearly period of use amounted to 29.4 hours in 1978.

R-32, Serial No. 021, Second Year of Use (8 months of operation during the first year of use)

① Miesiąc/rok		01/78	02/78	03/78	04/78	05/78	06/78	07/78	08/78	09/78	10/78	11/78	12/78
② Łączny czas pracy [h]	t_p	180	175,5	191	186,5	183	202	196,5	201	188,5	195	188,5	187
③ Łączny czas awarii [h]	t_a	33	45	16,5	19,5	58	20,5	52	32,5	75	23,5	20	5,5
④ Liczba przestojów awaryjnych	m_j	15	18	8	20	20	16	35	28	31	17	18	48
⑤ Średni czas między uszkodzeniami [h]	$T_{\lambda j}$	9,0	10,0	21,5	8,6	6,2	11,3	4,0	7,8	3,5	10,9	8,2	4,2

Key: 1) month/year; 2) total operating time (hours); 2) total breakdown time (hours); 3) number of breakdown interruptions; 5) average time between failures (hours).

The value $T_{\lambda j}$ for a yearly period of use amounted to 7.1 hours in 1978 (and $T_{\lambda j}$ to 8.8 hours in the previous year).

Notice that for the same type of machine, namely R-32, the results obtained by ZETO, Katowice, and by OE GUS, Warsaw, converge. It could not be otherwise, as reliability is undoubtedly an intrinsic property of an object, and not a feature of the quality of its technical maintenance. The technical service may indeed affect the operation of computer system for better or for worse, but it can not alter the intrinsic properties of this system. /7

Let us examine now how the obtained results pertaining $T_{\lambda j}$ for the machines ODRA 1305 and R-32; and for foreign machines, relate to the standards that are obligatory in our country.

NORMALIZING REQUIREMENTS AND DIAGRAMS OF THE RELIABILITY STRUCTURE OF A COMPUTER SYSTEM

According to the professional standard BN-78/3108-03, the minimum value of the time $T_{\lambda j}$ for computer equipment amounts to 100 hours.

Let us accept that a typical computer system is composed of the following equipment: 1 processor, 3 blocks of operating memory (each of 32K words), 1 operator's console (monitor, 1 ("double" duty) disc memories steering unit, 6 disc memories, 2 tape memories steering units, 8 tape memories, 2 line printers, 2 card readers, 1 paper tape reader, and 1 paper tape punch.

In the utilization practice, reserve equipment is most often functioning, i.e., is not disconnected and is ready for a failure of the basic equipment. The repair of any malfunctioning equipment occurs only after such equipment is disconnected from the operation. Such a system corresponds to a parallel reliability structure of a computer system, with the so-called reserve being loaded without repair.

If, with the acceptance of such a reliability structure of a computer system, we assume that the typical computer system, as

given above, comprises as reserve equipment:one memory block of 32K words, one disc memories steering unit, one disc memory, one tape memory steering unit, two tape memories, a printer, and one card reader; and that, at a given moment, only one piece of equipment of a given type undergoes failure, then the diagram of the reliability structure of the computer system under discussion may be represented as follows:

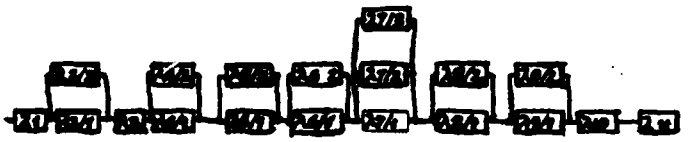


Figure 1. Diagram of the reliability structure of a computer system.

The symbols λ characterize the intensity of the malfunctions of:

- the processor (λ_1)
- the active memory block of 32K words ($\lambda_{2/1}$)
- the redundant memory block of 32K words ($\lambda_{2/2}$)
- the operator's console (λ_3)
- the disc memories steering unit ($\lambda_{4/1}$)
- the reserve disc memories steering unit ($\lambda_{4/2}$)
- the disc memory ($\lambda_{5/1}$)
- the disc memory reserve unit ($\lambda_{5/2}$)
- the tape memories steering unit ($\lambda_{6/1}$)
- the tape memories reserve steering unit ($\lambda_{6/2}$)
- the tape memory ($\lambda_{7/1}$)
- the two tape memory reserve units ($\lambda_{7/2}$, $\lambda_{7/3}$)
- the line printer ($\lambda_{8/1}$)
- the reserve line printer ($\lambda_{8/2}$)
- the paper tape reader ($\lambda_{9/1}$)
- the reserve card reader ($\lambda_{9/2}$)
- the paper tape reader (λ_{10})
- the paper tape punch (λ_{11}).

Finally, every diagram of the reliability structure can be put in the form of a series. In our case, the serial diagram of the reliability of the computer system is represented as follows:

Figure 2. Serial diagram of the reliability structure of a computer system.

The letter z next to the symbols denotes the failure replacement intensity for a given set of equipment. The replacement values /8
λ_{zn} are computed from the formula

$$\lambda_{zn} = \frac{1}{T_{\lambda zn}} \quad [h^{-1}] \tag{2}$$

following prior computation of $T_{\lambda zn}$ from the formula

$$T_{\lambda zn} = \frac{1}{\lambda} \sum_{i=1}^{k+1} \frac{1}{i} \quad [h] \tag{3}$$

corresponding to a parallel reliability structure with the reserve loaded without repair, where:

λ = intensity of equipment malfunctions (identical for all pieces of equipment in a given set)

k = number of reserve equipment units

n = identifier of a set of equipment.

The resulting failure intensity of the computer system λ_{ws} will be the sum of the intensities of the individual members of the serial diagram of the reliability structure of the mentioned system, namely:

$$\lambda_{ws} = \lambda_1 + \lambda_{s2} + \lambda_{s3} + \lambda_{s4} + \lambda_{s5} + \lambda_{s6} + \lambda_{s7} + \lambda_{s8} + \lambda_{s9} + \lambda_{s10} \quad [h^{-1}] \quad (4)$$

On the other hand, the average value of the time between two successive failures of the computer system $T_{\lambda ws}$ is computed from the relation

$$T_{\lambda ws} = \frac{1}{\lambda_{ws}} \quad [h] \quad (5)$$

Computations of $T_{\lambda ws}$

Let us examine three different cases, namely:

1) establishment of minimal T_λ for the individual computer components;

2) acceptance of the T_λ values stated by national equipment manufacturers;

3) acceptance of the T_λ values stated by foreign manufacturers of computer equipment (according to DATAMATION, No. 9/78).

Case 1

As already mentioned above, the professional standard BN-78/3208-03 defines $T_{\lambda min}$ = 100 hours for any arbitrary computer component. On the basis of formulas (2), (3), (4), and (5), we can compute the minimum mean time $T_{\lambda ws}$ min [hours] between two successive failures of a computer system.

Case 2

The suppliers or producers of national computer equipment give the following values of the times T_λ for the following equipment:

Central unit ODRA 1305 with an active memory of 32K words	- 120 hours
Operator's console (Facit or DZM 180/05)	- 1500 hours
Disc memories steering unit (pds 325)	- 1000 hours
Disc memory (of Bulgarian manufacture)	- 1000 hours
Tape memories steering unit (MTS 25-02)	- 450 hours
Tape memory (PT-3)	- 500 hours
Line printer (DW 325)	- 1000 hours
Card reader (CK 325)	- 450 hours
Paper tape reader (CDT 325 - part of the reader)	- 500 hours
Paper tape punch (CDT 325 - part of the punch)	- 200 hours

For the above data,we obtain a value of the average time between two successive failures of the national computer system $T_{\lambda ws}$= 37.0 hours.

Case 3

According to the data contained in DATAMATION, No. 9/78, the typical values of the times T_λ for particular computer components in western countries are at present as follows:

Processor	- 1000 hours
Internal memory blocks 1MB	- 4000 hours
Disc or tape memories steering unit	- 3000 hours
Disc memory	- 2500 hours
Tape memory	- 1000 hours
Line printer	- 300 hours

Without committing a major error, we can assume that T_λ amounts to 500 hours for the paper tape reader, 450 hours for the card reader, 200 hours for the paper tape punch, and 1500 hours for the operator's console.

For the above dat we obtain a value of the average time between two successive failures of a western computer system $T_{\lambda ws}$ = 72.3 hours.

PRELIMINARY ANALYSIS OF THE RESULTS OF THE COMPUTATIONS

If we compare the real $T_{\lambda 12}$ (see the Tables) for the ODRA 1305 (20-30 hours) and R-32 (7-11 hours) computers with the obtained time $T_{\lambda ws\ min}$, then we note again an agreement between the theoretical calculations and the utilization practice.

The ODRA 1305 computers are substantially above the minimum limit of the time T_{λ} (11.7 hours) calculated for a typical computer system based on the professional standard; whereas the R-32 computers of ZETO, Katowice, and OE GUS, Warsaw, are below this minimum limit.

A comparison of the value $T_{\lambda ws}$ (37.0 hours), calculated on the basis of the times T_{λ} stated by the national computer equipment manufacturers, with the real value $T_{\lambda 12}$ (20-30 hours) for the ODRA 1305 machines shows up at a disadvantage. This testifies to either an erroneous calculation of the theoretical parameters of computer equipment or to an underestimation of the problem in the manufacturing process. To those who seek to lay all the blame on the user of the system, and hence on a bad performance of the technical service personnel, it may be answered that foreign machines serviced by the same technical cadre stand up to all comparisons with theoretical calculations, and even surpass in practice the theoretical results, in a positive sense.

It is worth adding, at this point, that the setting of $T_{\lambda min}$ = 100 hours in the professional standard for computer components is not sufficiently challenging to the manufacturers of this equipment; and therefore, in the stage of creation of a Polish standard, the level of the requirements should be appropriately raised.

In conclusion, it is also worth drawing attention to the matter of programming computer systems and equipping them with interchangeable parts. Programming (systemic, utilizational, diagnostic) and interchangeable parts form undoubtedly an integral part of a computer system, and must therefore be treated on an equal basis with the equipment. Regrettably, this is not confirmed in our utilizational practice, as interchangeable parts are chronically lacking, and the programming is only partly and very belatedly modernized.

6-8
DTI